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TRANSACTIONS

of the

American Fisheries Society

"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

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CONTENTS

METHODS OF COLLECTING AND HATCHING BUFFALO-FISH EGGS AT THE U. S. FISHERIES BIOLOGICAL STATION, FAIRPORT, IOWA.

By H. L. CANFIELD,
Superintendent of Fish-culture.

The rapidly decreasing supply of the food fishes of the Mississippi River and tributary streams, makes imperative the need for additional knowledge regarding their habits. More applicable measures for their protection may then be instituted and the natural increase may be supplemented, as far as possible, by artificial means. Prior to the time the work was taken up in an experimental way at the Fairport Station, absolute failure or, at most, very little success had resulted from the efforts of fish culturists to collect and hatch the eggs of the buffalo-fishes of the genus *Ictiobus*. A brief statement, then, of the methods we have employed and the results obtained, will be of interest and value.

The spawning of the buffalo-fishes, of which there are three recognized species in our vicinity, takes place ordinarily between April 15th and May 15th, in that section of the Mississippi River between Davenport and Keokuk, Iowa, at which time the annual spring rise of the river occurs. During this rise the lowlands, which in times of ordinary water stages are dry, become inundated and furnish very favorable spawning grounds for the buffalo. Knowing the movements of the fish and realizing the impossibility of taking many of them with seines, the commercial fishermen catch them chiefly with fyke-nets provided with wings and with funnel hoop-nets. The fyke-nets are set mainly on inundated lands in the woods adjacent to rivers and inland sloughs, where there is a current of water, while the hoop-nets are used along the shores and entrances to inland sloughs. The larger part of the eggs hatched at Fairport during the past three seasons was secured from fish taken and marketed by the commercial fishermen, thus representing a supply which would otherwise have been a total loss. It has been noted that, as the water recedes the catch of buffalo greatly diminishes. From the fact that many of these, taken at this time, are still unripe, it is presumed that such unripe fish naturally

return to the river, perhaps to seek more favorable spawning grounds. It is necessary, therefore, to prosecute the work vigorously during the rising stage of the river.

The larger fish markets furnish table space and equipment to the fishermen for dressing and weighing their fish and purchase them when ready for the market. In localities where this method of sale prevails the fisherman visits his nets, raises and empties them, and on completion of the rounds proceeds to the fish market. Although this method of handling the fish is quite rough, the fish arrive at the market alive, even though they have been removed from the water from one to four hours, the weather being quite cool at this season of the year. Promptly on arrival, our spawntakers go over the catches, stripping and fertilizing all ripe eggs. This arrangement makes the collection of the eggs quite economical, with minimum annoyance to the fishermen. A gentler way would be to have the spawntakers accompany the fishermen and take the eggs as the fish are removed from the nets, but this would require the services of a prohibitive number of spawntakers. Furthermore, so far as we have been able to determine, no definite injury is done the eggs by handling the fish in this manner. The hatch appears to be quite as good and the fry as strong as when the eggs are obtained from fish immediately after their removal from the water. In localities where fish are prepared for market in the field, it is necessary to collect the eggs at scattering fishermen's headquarters. This is done by accompanying the fishermen to the nets or by instructing them how to take and care for the eggs until they can be gathered up by a member of the Station force.

The work done at the Station in the propagation of the buffalofish has been much appreciated by the active fishermen and market men of the region. They have co-operated fully in facilitating the egg-collecting and have assisted in every way possible, giving freely of their time and labor for the good of the work.

In spawning the fish, the pan is rinsed with water and drained, but not dried. The female fish is held in the usual manner over the pan and the eggs are ejected into it by gentle pressure over the ovaries and toward the vent. The milt from the male fish is then stripped into the pan by a similar process. The contents of the pan are gently and thoroughly stirred with the fingers at intervals

for about five minutes, to insure impregnation. Two tablespoonfuls of ordinary corn starch are now added and thoroughly stirred in for about ten minutes to keep the eggs separated. After this the eggs are washed by gently pouring water into and then out of the pan, repeating the process until the eggs are quite clean, gently stirring them meanwhile to keep the eggs separated. During washing, the eggs become water hardened.

If a hatching battery is near at hand, the eggs may now be transported to it in a pail or other receptacle. If shipment is necessary the eggs are poured on canton flannel trays and the trays stacked and placed in the ordinary field shipping box, with the upper tray serving as an ice hopper and the lower one as a cushion for the balance of the stack. On arrival at the station the eggs are tempered carefully and the trays are then moistened by floating them in tanks. As the eggs have become cemented together and to the trays, in transit, they must be gently scraped off in enmassed strips, by means of a dull hand scraper and placed in a tub of fresh water. They are then washed and brushed through a one-eighth inch mesh bobbinet-bottomed tray into a tub of clean water. In this process the tray is held so that the eggs are slightly immersed in the water. By sifting and by raising and lowering the tray and gently brushing the eggs through the meshes with the fingers, or with an ordinary paint brush, the process is made more easy for the operator and safe to the eggs.

After this process the eggs are again washed by changes of water as previously described, then poured into the Downing jars, placed on the battery shelves and running water admitted. The following day it is necessary to again pass the eggs through the bobbinet tray to separate them, but under ordinary conditions no further trouble of this nature occurs. In the event of the eggs becoming enmassed by fungus, they should be washed and separated and the good eggs given a dip or quick bath in a weak salt solution, sufficiently strong to remove the fungus.

It should be emphasized that roily water is not troublesome and as the ordinary river water is of the proper temperature, it is preferable to clear water of lower temperature obtained from springs or otherwise. Temperatures fluctuating between 52 and 62 degrees Fahr. have given no trouble but a range of 56 to 62

degrees is still better. If the best results are to be obtained unfavorable temperatures should, of course, be avoided.

The eggs measure 180,000 to the fluid quart, are of a light amber color and very glutinous. They "eye" in three to four days at an average temperature of 62 degrees and hatch in nine or ten days. The fry are approximately three-sixteenths of an inch long when hatched, and the yolk sac is completely absorbed in about three days. The fry swim up nicely and are not cannibalistic.

A very fine meshed screen must be used in screening the fry retaining-tank, in order to prevent the escape of the young fish.

PLANTING FISH IN AN ALKALI LAKE.

By ALFRED EASTGATE,
St. John, N. D.

The line of work on which I shall report was begun five years ago by the Biological Station of North Dakota in the effort to find the proper means of restocking the lakes of this state. In former years these lakes were full of fish of various kinds, weighing up to thirty-five pounds.

In the latter eighties there was a very dry year and the water was greatly lowered, resulting, of course, in greater concentration of the salts. At the same time the fishermen continued their operations on the restricted water area and eventually the entire fish supply of Devils Lake was exterminated. This lake, which comprises about forty-five thousand acres at the present time, for several years furnished fish dealers contracts calling for three to seven carloads of fish a week. In 1886 I saw a great haul made with a net so large that four horses on each side were required to land the catch. The fish were shoveled into great tanks and shipped in refrigerator cars. That is the way in which the supply was exhausted.

After a few years the cry went up that fish could no longer live in Devils Lake on account of the salt water. The water, of course, is what we commonly call alkali and it contains about thirteen per cent of solids, with a mixture of several salts.

Prof. M. A. Brannon, of the State University, took up the work of finding out why the fish did not live in Devils Lake. He went at it systematically and studied the water and all its contents, with the plant and animal life, but could find no reason. About ninety-seven per cent of the fish introduced from fresh water died immediately.

Dr. Brannon worked on this problem about five years before I was called into the service. My work was simply to do what he laid out for me, to carry on the practical work in accordance with his suggestions. The state fish commissioner at that time did not think much of scientific work along fisheries lines and would not

co-operate in any way, except to grudgingly supply a few fish and spawn. The first bunch of fish we hatched were steel-head trout. As we had no facilities at the Laboratory, I hatched them at the State University at Grand Forks and transported them to the lake when they were ready to plant. We also had some wall-eyed pike. The work that summer was rather discouraging.

The next summer things were in better shape at the laboratory, and it was then that Dr. Brannon made a discovery which has proved to be the solution of our difficulty. He was working on the plants of the lake and found that those living in the alkali water showed a pressure five times as great as those living in fresh water. Immediately we planned out a new line of work, applying the same principle made use of to accommodate a man to work under high air pressure, that is, the man goes from one chamber to another with increasing pressure until finally he is able to work in a pressure that would kill him in five minutes if he went there directly. When he is done with his shift he goes back gradually and is none the worse for it.

We constructed a series of cement tanks for experimentation and in six weeks had worked out the problem with great success. The fish are put into fresh water for a day and then twenty per cent of the alkali water is added. The next day the percentage of alkali water is raised to forty and the next day to eighty. Then they go into the full strength alkali water for a day, after which they are ready to go into the Lake, with a loss of only about one-tenth of one per cent. We have tried black bass, steel-head and rainbow trout, wall-eyed pike, bull-head and pickerel (though the pickerel are not to be introduced into the lake). We hope to have the plant enlarged, as the one in use was built merely for experimental purposes.

We have also tried the experiment of hatching eggs in the alkali water. We received the eggs from Put-in-Bay, Ohio, and so put them all in fresh water, except one jar which was supplied with the lake water. The fish hatched in the alkali water are better and stronger and in the five years that we have used the pure lake water we have failed to find the least trace of fungus. You all know how interesting it is to work with fungused wall-eyed pike eggs, but we have seen no trace in the alkali water.

A week ago I seined in Devils Lake, because it was said that there were no longer any fish there. In spite of the difficulties of seining in water filled with heavy vegetation I drew out three large fish. It is merely a matter of business to restock the Lake. If the people can be interested enough so that they will plant the lake by millions instead of a few thousands it will be only a matter of a little time till the lake will be as full of fish as it ever was. The natural food supply is abundant.

The density of Devils Lake varies greatly from April to the last of August, at which time it reaches about its lowest stage.

Those of you from the east do not have to deal with alkali waters, but to those of you who do I would say, by all means get in touch with your universities and have them make a complete investigation.

THE LAKE SUPERIOR HERRING.

By A. C. Dunn,
Duluth, Minn.

It is not the intention of this paper to discourse learnedly on the inner secrets of the life history of our fish or other members of the wild life coming under the observation of those generally interested in game and fish from a sportsman's standpoint. The writer has probably fished and hunted more than the average citizen, as is the usual case of those brought up in the more primitive environs of Northern Minnesota. However, for the past three years it has been necessary for me to confine my attention to commercial fisheries and make a study of them, in order to convert the natural resources of Lake Superior into the more usable dollars.

To the majority of those here assembled Duluth is not considered a fishing port, and of those who are aware that more or less fish are shipped from Duluth, only a very few know to what magnitude the fishing industry has grown. Indeed, our own neighbors at home would scarcely believe that there are more than a dozen companies competing tooth and nail for a share of the business. So keen has this competition become that an altogether unique sales condition has grown up among us, peculiar only to Duluth.

Lake Superior does not produce many commercial varieties. Indeed, outside of the herring and trout, there are only a few fish of any importance. The sale of Menominees, Bluefins, Ciscoes and Whitefish, is only a very minor and insignificant item as compared with that of the Lake Superior Herring.

Last year, in order to improve conditions in the fisheries of Lake Superior, so far as Minnesota was concerned, we were very ably assisted by the Game and Fish Commission, and especially by our local game warden, John Green, and through his efforts very authentic statistics bearing on the question were secured. It was shown that there were then 350 fishermen engaged in the industry, at least 320 of whom were independent operators, living on their own or leased property, making the business of fishing practically their only means of livelihood. Their combined outfits, including nets, skiffs, etc., was estimated at upwards of $65,000.00.

As we have said, there are a dozen firms engaged in the gathering and disposal of their output. There are five good sized steamers and seven or more gasoline freighters in the service of these companies, the combined value of which would probably reach $150,000.00, employing, during the busy season, 88 men on a payroll running to $6,340.00 per month.

The property of those companies which are fortunate enough to own dock frontage is estimated at $175,000. Others rent or pay storage to the extent of about $9,000.00 per year. Their combined office and warehouse monthly payrolls, during the season, runs to $6500 per month.

All these figures, no doubt, are tedious, but I am endeavoring to show that there is a considerable organization at work constantly and unremittingly drawing on the natural resources of the lake. Nor are its efforts unrewarded. An average of the catches for the past two or three years will show that the annual production of herring alone is enormous, being no less than 3,000,000 pounds sold in the fresh or frozen state and 3,500,000 pounds sold in brine. At present prices, this great total may be valued at more than a third of a million dollars. Then there are upwards of 75,000 pounds of trout produced each year at a value of approximately ten thousand dollars. Of the other fish produced and shipped at Duluth the total would not be much more than 20,000 pounds. The fish brought into the Duluth port are taken between Duluth and the Canadian border and around Isle Royale.

Many people familiar with the fisheries I speak of, and some who are still engaged in them, will tell you that there are just as many herring in the lake as ever, or even that they are on the increase, but I must tell you, though I am an operator in the exploitation of these fish, that this is not the case. Further than that, I insist that they are diminishing very rapidly. It is true that the annual catch has not decreased as alarmingly as one might at first surmise from the above figures. But take into consideration the fact that the fishermen must now use several times as much twine to catch the same amount of fish; that they must venture out farther for them; that, with the increase in prices, more fishermen are working, and we see why the production has not decreased. But furthermore, (and here is the point I wish

especially to make) consider that scores and scores of tons of fish are now being caught on the spawning beds to be salted or frozen—which is a condition that did not formerly exist—and it is not difficult to realize that the end is in sight. This sort of thing cannot continue much longer or we will all automatically go out of business with the extinction of the herring, just as the famous catches of Lake Superior Whitefish are now gone, probably forever.

The remedy is simple and yet, on account of our foolish system of allowing each state to make its own game laws, this by no means small portion of the nation's natural resources is in danger of obliteration. In spite of the fact that it meant a temporary heavy financial loss to some of us last winter, we worked with the Minnesota State Game and Fish Commission to correct the condition, and did actually get passed a bill which increased the required size of the mesh to be used in the gill nets. This means that no more undersized herring can be legally caught in Minnesota waters. The law also establishes a closed season to protect the herring when spawning, this latter provision to become operative upon the passage of a similar law in Wisconsin. But right here is the difficulty; practically all the herring at the western end of the lake begin to congregate in the late fall in great schools, following the north shore westward until the spawning time arrives, which is usually about the 10th of November. At that time they appear in millions, not in Minnesota waters, but over the great muddy bottoms in the shallower Wisconsin waters at the extreme western end of the south shore of the lake. Here they congregate for three weeks for spawning and then, as suddenly as they appeared, they go.

The problem is now one for Wisconsin to deal with. The fishermen's lobby at Madison have side-tracked every effort made in that direction for years. They did pass one closed season bill, but instead of protecting the spawning fish they closed the season for a month before that period. It is well to protect the fish which are about to spawn, but it is certain that the damage that could be inflicted at that time is insignificant beside the other.

I am firmly of the opinion that migratory fish, like migratory birds, should be protected by Federal laws. These are not Minnesota's fish, nor Wisconsin's fish, nor Michigan's fish, though the

same fish traverse the shores of all these states. They need conservation as do the migratory birds. But, until we can get a national measure passed, something should be done to get Wisconsin into line. I urge this with full knowledge that my company will be one to suffer directly therefrom. It is not merely a conscience one must have to meet this condition, he must also have an eye for business, which is quite as important, and, unless I am very much mistaken, at the present rate of wholesale destruction of herring, in another five years the game will not be worth the candle.

INCREASING THE OUTPUT.

By W. O. Buck,
Neosho, Mo.

Mother Nature seems to be constantly trying to increase the output of fish and has adopted several details of plan to effect this. Enormous fecundity is perhaps the most important of these, but the concealment of eggs and young and the protection of both by parent fish work to the same end. Apparently these should soon carry the output to infinity, but in fact a limit is soon reached and lakes and streams and even the ocean are but sparsely stocked with fish and are easily depleted. In seeking the explanation of this we find it in the limitation of the food supply.

When we try to improve upon nature in the supply of young fish, the best we can do is to limp along her path and, since we cannot control fecundity, we must increase the number of breeders and give their offspring more protection and a better supply of food.

With trout and salmon running wild and handled only at spawning time the problem is comparatively simple, since the fish will be healthy and their numbers can be maintained with moderate effort. When trout must be bred and held in confinement, however, several new factors are introduced. The most conspicuous of these is crowding. Although some sorts of fish all through life, and perhaps all sorts at some stage, run together in schools, trout do so only for a short time. Every fish culturist knows that, as soon as they rise and begin to seek food, trout will separate as widely as they can. When food is thrown to them they rush at it from all directions and some are likely to get hurt when they meet.

Then, too, trout are stream fish and most artificial tanks or ponds fail to provide the best conditions for them. It is also necessary to offer them food which is entirely different from that on which the wild fish subsist. It is small wonder then that under such conditions the fish are not quite normal. Even so, we may and do attain a fair degree of success in propagating them, but when we try to do still better we must get back a little nearer to natural conditions.

Probably some part of the food should be such as the wild fish are accustomed to take and access to running water is doubtless desirable. All ways in which fish may be injured should be eliminated so far as may be. A brood stock may then be expected to live longer and, as older fish produce more eggs than young ones, the output will increase. But as the stock will inevitably grow less in numbers each year, the final resource for maintaining and increasing the output will be to add to the number of young breeders.

With pond fish, not artificially fed, the output may be increased by increasing the number of breeders, provided the young are promptly captured and given room elsewhere, but, since the limit of food supply is soon reached in stocking a pond with brood fish, more breeders may mean less output of young if all are left together. Not only will the old fish eat the young, but the young will eat one another. We all know this, but do not all agree as to what we shall do about it. In one instance about fifty black bass breeders were allowed to spawn in a pond of about a half acre, poorly supplied with plants, and the young allowed to remain till about the middle of July, when the pond was drawn and only thirteen were found. In his "Aquatic Plants in Pond Culture" Mr. Titcomb mentions an instance in which 20,000 young bass were placed by themselves in a half-acre pond in April and eight weeks later 6,000 well-grown fingerlings remained. In this case the pond was well supplied with plants and insect fish food.

It is probably clear to us all that young bass should be collected and distributed very early, not to make a record, but to give them their chance for life, which will be but slender if they are left in the brood ponds with the parent fish and especially if the ponds are stocked to the food limit or beyond. The question then comes as to the mode of collecting the young. Since the food supply for young and old depends on the maintenance of plant growth, it is necessary to adopt a method which will leave the plants undisturbed. Fortunately, young bass soon after leaving the nest will start on a tour of exploration around the margin of the pond, going in schools and these schools may be captured with a fine seine and placed in a tub or bucket, with small harm to fish or plants. Those that escape capture may be allowed to remain till fall, when the pond can be drawn.

Seining the whole pond does so much harm to the plants that it will probably be well to draw the pond in summer and remove both young and old fish, where this can be arranged. In practice it seems to me still better to protect the plants and use all the ponds the whole season, with the idea that the first and last essential of pond culture is food production. But it is not quite enough to protect volunteer plants, nor even to introduce plants at every opportunity. A selection should be made. Some are useful in protecting banks, where these are made of earth. Sawgrass, mint, flags, rushes, sagittaria, pontedaria, water-plantain, water-willow, water-purslane, etc., will do this, but not all are desirable.

Good qualities may be more than balanced by bad ones, as in the case of cattail flag, which will bind the bottom along the shore line very effectually and provide shade and shelter, but promptly becomes a nuisance by over-crowding and choking out everything else.

While along the margin a leading purpose of plants may be to protect the banks as well as provide shelter, for the body of the pond the object will be to furnish suitable conditions and pasture for the small creatures necessary for natural fish food. Here is where we all need more light. We do not certainly know just what the various kinds of fish need for food. Nor has it yet been made clear what conditions are most favorable for the production of any kind of food creatures. Our honored ex-president in attacking the problem of how how many food fishes it is possible for the Great Lakes to support included a study of aquatic plants and their dependence on the bottom for the elements of growth. Dr. Raymond H. Pond, as a result of his experiments, states that "the amount of plankton produced by bodies of fresh water is, other things being equal, in some inverse ratio proportional to the amount of its non-rooted vegetation and in some direct ratio proportional to the amount of its gross rooted vegetation." He goes on to draw the inference that: "In the stocking of ponds for fish culture, care should be taken to have a good soil for the bottom; not a stiff clay or sand, but a good loamy soil, such as is favorable for land plants. The species allowed to grow should be those which are known to possess roots and to be very dependent upon the soil, such as *Vallisneria spiralis*, the so-called fresh

water eel-grass, and *Potamogeton*, or pond weeds; not forms without roots, such as *Ceratophyllum*, or those less dependent upon the soil." (See Dr. Pond's "Relation of Aquatic Plants to Substratum," published in U. S. Fish Com. Bulletin for 1903.)

Realizing the need of plants in our ponds, most of us put in anything and everything which we can get to grow, and this is no doubt better than to plant nothing, but we may do still better by learning to know our friends from our enemies. As a guide to this, Titcomb's "Aquatic Plants in Pond Culture," published as Bureau of Fisheries Document No. 643 and included in the volume of bulletins for 1907 is invaluable. Bulletin No. 815, Moore's "Potamogetons in Relation to Pond Culture," with its full references to bibliography of allied subjects, also lets in the light for those who will use it.

Not all of us have access to these papers so the following suggestions are offered:

Keep plants out of trout ponds, but fill bass ponds with *Chara*, the *Potamogetons*, *Ranunculus*, *Philotria* (*Elodea*) and *Naias* in the main part of the pond and *Sagittaria* and rushes to bind earth banks.

Avoid cattail, water-lilies and parrotfeather.*

Handle your ponds so as to avoid injury to the plants and when a pond is drawn transfer the plants before they wilt to some other pond, unless all are abundantly supplied.

But all this deals only with the fishculturist's part of the problem—that of increasing the output of fish to be planted. The really important part is that of increasing the output of matured fish from our ponds and streams, public and private, and to solve this we must consider not only all that has gone before, but also the questions of what fish to plant and where and when and how.

Professor Needham, in his article on "Fish-culture" reprinted in his recent book, "Life of Inland Waters," emphasizes the importance of this part of the fishcultural problem, suggesting that "The hatcheries are raising fry and not fishes." "The planting of fry and fingerlings is effective where conditions permit of their growth." "The conditions in the wild are not such as yield much

* Dried specimens of some of the common pond plants mentioned were exhibited by the author.

advantage from this intensive propagation of the young." "Feeding fishes on the young of their own kind is not good husbandry." "Raising animals and their forage together is not good husbandry." These sentences are quoted out of their order and connection, but they furnish food for thought and material for discussion, because the line of argument is that fishculture must follow the lines of animal culture. But is there not a wide difference? It is not an economical use of land to make a pasture of it. Animals will trample down and destroy far more than they will eat. But fish do not do this. Then the assertion that it is not good husbandry to feed fishes on the young of their own kind sounds convincing, but is there not room for some modification of this statement in view of the fact that it is the rule for fishes to feed on their own young, and that the enormous fecundity of fishes is nature's admission of the fact? Or, shall we not still insist that it is, nevertheless, bad husbandry and that nature cannot help it and that therefore we should assist her in every way possible to increase production?

MIXING TROUT IN WESTERN WATERS.

By ALDO LEOPOLD,
U. S. Forest Service, Albuquerque, New Mexico.

If a stream is stocked with 10,000 native trout, 10,000 eastern brook trout, and 10,000 rainbow trout, and granting that the conditions are suited to each of them, will that stream produce more or less pounds of trout per year than if stocked with 30,000 of any one of the three? In the west, at least, this is a live question which does not seem to have received serious study. It is the object of this paper to summarize such data as the United States Forest Service has been able to collect with the object of arriving at an answer. At least a tentative answer is needed as a guide to practice.

The question obviously involves variable local factors whose reactions are not susceptible to generalization. These variable factors may even preclude a general "yes" or "no" in answer to the question. Then, too little is known about the actual relations of the species to their environment and to each other to allow of reaching an answer by inductive reasoning. However, the question seems to involve the law of hybridization, from which important conclusions bearing on rules of practice can easily be deduced, and furthermore, the question can, to some degree, be illuminated empirically from actual observations.

The United States Bureau of Fisheries is authority for the statement that the trout hybrids so far studied have been fertile, but decreasingly so with successive generations. The Bureau believes, however, that hybridization is rare, but states that nobody knows exactly how rare. The law of hybrids would indicate that any trout hybrids which do occur between definite species are infertile, or at least less fertile than the pure stock. In either case the existence of hybrids would reduce the productive capacity of the water in which they occur. They must necessarily consume food which might be used by more fertile fish.

The actual observations of the writer, though meagre and confined to the southwest, are as follows:

1. Rainbow, eastern brook, cutthroat, and German brown trout have been indiscriminately mixed with the native black-spotted trout of our southwestern streams.

2. Where so mixed, it is commonly believed by fishermen that, (a), the rainbow and black-spotted trout have crossed

extensively, although the alleged hybrids have never been scientifically identified as such; (b) the German brown trout has not hybridized, but is preying extensively on the others and is becoming predominant; (c) the eastern brook-trout has not hybridized (for the obvious reason that they spawn in the fall and cannot hybridize with spring-spawning species).

3. It is the writer's impression that the streams stocked with several species do not "stand up" under the drain of heavy fishing quite as well as those with only one species. One of the most resistant streams known to the writer is Sabino Canyon in the Coronado National Forest, almost on the Mexican boundary. It was stocked once with eastern brook trout in 1908, has been heavily fished ever since, and showed no sign of giving out until this year. Much less resistant is the Pecos River in the Santa Fe National Forest, a much larger stream. It has been stocked every year with black-spotted, rainbow or German brown trout, and is no more heavily fished, in proportion to its size, than the Sabino. These impressions are, of course, merely indicative.

It appears therefore that available knowledge on the question of mixing species, may be summarized as follows:

1. Species of trout spawning at the same time may hybridize. More knowledge is needed on when and to what extent.

2. These hybrids are less productive, and therefore less desirable, than pure stock. More knowledge is needed on how much their reproductive capacity is reduced.

From the foregoing conclusions, the Southwestern District of the Forest Service has arrived at and is now adhering to the following rules of practice in stocking trout waters in the National Forests of Arizona and New Mexico:

1. Nature, in stocking trout waters, sticks to one species. The Forest Service will do likewise where mixing has not already occurred.

2. Empty waters will be stocked with the species that seems most suitable. Where there is danger of depletion through heavy fishing, avoid rainbows. Where there is danger of the water being too warm, avoid black-spotted and eastern brook-trout. Where a lake is large or mud-bottomed or warm or otherwise liable to produce large non-rising fish, avoid the native black-spotted trout.

3. Stocked waters will not be further mixed. Restock with the best adapted species, the native species always preferred.

IMPROVE THE CANNED FISH PRODUCT.

By K. HOVDEN,
Monterey, California.

Under the present business conditions and with a scarcity of tin, it behooves the canners of this country to furnish the public with as good products as possible, instead of wasting time and tin-plate in packing inferior goods to become a glut on the market, which is a tendency shown by many canners at the present day.

Many of our numerous canners do not seem to understand the first principles of cooking, which is an essential thing for any canner aside, perhaps, from those engaged in canning salmon. The process of salmon canning is more or less mechanical, as it is not processed nor prepared for the table in any other way but by cooking in the tin.

Sardines require greater skill and more training. The fish vary in the amount of fat and protein according to the season and, in the writer's opinion they should not be canned in the winter and early spring, when they are spawning, as they are then too poor in food value and contain scarcely any fat.

As the Department of Agriculture is trying to educate the people in the preparation of food for cattle, hogs, etc., it would not be out of the way for the proper authorities to teach the canners how best to prepare canned fish for human consumption. It might be very interesting if samples of the products of various packers could be analyzed for comparison. If then, it were required to sell the product according to analysis, all packers would be compelled to put up a good article, or the people would not buy their products. Sometimes there is more waste product than digestible food in a can and the public should not unwittingly be taxed with a costly container holding such a product.

Most of our edible fish are being utilized, but the manner in which they are prepared for the public is often not on a scientific basis. The products should be standardized, the government should maintain schools for the education of canners and, in fact, no cannery should be permitted to operate unless the man in charge of the plant has sufficient education and knowledge of scientific methods of preparing food products for human con-

sumption. In this way we should be able to meet foreign competition here and to conquer markets outside of America. We have a vast supply of fish which, in other countries really cost more fresh than we can produce it for in tins.

In Europe the tins and sizes of fish are standardized. In Norway the packers agreed not to pack winter fish, so as not to injure the reputation of Norway sardines. American packers, especially in the present crisis, ought not be averse to helping the people and the government in saving tin plate, by packing only a nourishing food product. In this way they may serve the country by serving the public right, even if the immediate result should not be so profitable.

FEDERAL CONTROL OF FISHING IN THE MISSISSIPPI RIVER.

By M. N. Lipinsky,
Winona, Minn.

Commercial fishing on the upper Mississippi has for some time been considered a dishonorable trade, at least to a certain extent. This is due to the misunderstanding of laws, rather than to wilful violations, but it is not just to discredit the business of all engaged in commercial fishing on account of the acts of a few, especially when such great results are obtained with very little actual cost to the respective states or to the Federal Government.

The carp is the principal fish of the upper Mississippi and requires the least attention, for it is a prolific breeder, grows rapidly, is very good eating when properly prepared, and is of great value to the states concerned and to the commercial fishermen.

The fish commonly known as buffalo is also a very valuable food fish, and a native of the Mississippi River. These two are the principal fish, speaking commercially, of the Mississippi, and by proper propagation, either artificially or naturally, the Mississippi would produce at least ten times the amount of food fish it is producing today.

The greatest damage to natural breeding places is caused by the construction of railroads, dams and dikes which allow the

fish to enter in high water, but shut them off later and cause suffocation in winter. Such places should be attended to first, as I believe here lies the greatest danger to the small fish.

If I may be allowed to suggest a good, permanent way to conserve the small fish which get into the land-locked lakes and bays in high water, it would be to use steam shovels or ditching machines and connect the ponds and lakes with ditches that deepen as they run into the river. In a good many places artesian wells could be used very successfully. The different states have different ideas and opinions regarding fish and game laws and to avoid trouble we should have federal laws on interstate waters—that is, specifically, a uniform law for all the states bordering on the upper Mississippi.

We all know there is a question as to jurisdiction on the Mississippi, but be it state or federal, there should be something done to aid in the already valuable work being done in seining out some of the land-locked ponds. There are millions of these small fish that suffocate each winter along the Mississippi valley and if given proper protection from the heavy winter killings, as we commonly call it, we would have an abundance of all the different varieties of fish. I wish I could produce the record of the exact amount of fish taken out commercially from these waters each year, but it is impossible at this time, as most fishermen do not keep any records of their catches.

I make no criticism of the good work already done, but merely express my view of the conditions as seen in my immediate vicinity, with some suggestions as to their improvement. There are many arguments in favor of federal control of the finest fishing stream in the world, the Mississippi River.

THE GENERAL ROUTINE OF A TROUT HATCHERY.

By R. L. Ripple,
Bayfield Fish Hatchery, Bayfield, Wis.

Where can there be a line of work more fascinating, or less monotonous as a daily vocation than that of a brook and lake trout hatchery, where many millions of both varieties are handled every year? The trout hatchery is mentioned in this instance in preference to those where other varieties of fish are handled, because the breeders are reared from infancy and kept in the ponds the year round, and must be fed and cared for and kept in a good condition. The fertility of the eggs and the vitality of the little fish which result from the spawning season each year, depend on the manner in which the adult trout have been fed and otherwise cared for, the same as with stock or anything else.

Where can there be a more contented man than he who in the fall of the year, as the spawning season approaches, removes the thousands of trout breeders of various ages and sizes to the hatchery spawning raceways, and finds them to be fit and ready for the yearly production? The spawning is the fish man's harvest and the results of a year's careful and painstaking work are at hand. Perhaps during the year there were many trials and worries, but the condition of the fish, as they are removed from the ponds to the spawning races, shows that all is well.

However, strive as the hatchery man will to prevent it, there is always a certain loss of breeders in the stock fish ponds that is put down as unaccountable. We count each year, one by one at spawning time, all the fish put into the ponds. We keep an accurate account of all dead fish removed from each pond during the year, but still there is always a shortage, for the fish in the ponds have many enemies, such as the blue heron, muskrat and kingfisher. The blue heron is one of the greatest consumers of fish that we have to contend with, as it does its work at night, and I have had very good reason to believe that that great vegetarian, the muskrat, will go on a meat diet when he wants to go fishing for a change. There is a much larger number of trout and trout fry consumed every year from the ponds than many people have any idea of.

Our station at Bayfield has a capacity of about 20 double hatching troughs, 11 boxes long, 22 boxes to the double trough, each box holding 7 trays at two quarts per tray. When the hatchery is filled with its quota of lake trout, brook trout and brown trout eggs, it means many millions. Only those of you who have the thing to do can realize what effort it takes to fill these many stations, especially in the case of the lake trout, as they must be netted in the Great Lakes by the commercial fishermen in the late fall. Only one who has experienced the work can tell what a fight with the elements and unfavorable conditions it means to bring home each fall this harvest of spawn.

The spawning season over, the responsibilities grow heavy on the hatchery men. Millions of fish lives are contained in those eggs. The running water is passing over them, and must be kept passing. The ten to twenty-five per cent of infertile eggs must be removed as they begin to decay. Instead of the time-worn plan of picking them out with tweezers by hand, we use the more modern method, the brine box. In this the trays are placed, several at a time, the brine solution allowing the bad eggs, which are lighter, to come to the top, where they are scraped off with a small net. Two men, in the same time, now do what it formerly took eight or ten men to do.

For 110 days, on the average, these millions of eggs must remain on the hatchery trays, bringing the hatching season along into March or the latter part of February, in our locality. When the lake trout fry are ready, being some six weeks old, they are taken out in boats and planted on the reefs and spawning beds, where they would naturally hatch. I can not attempt to tell in so brief an article what their lot would have been had they remained on those reefs for 110 days. We have prevented, however, some of that tremendous loss that occurs yearly in nature.

The millions of brook and other trout fry are now placed in the various feeding tanks and rearing ponds, and again, as always, the hatchery man has his work cut out for him.

Shipping time is now at hand. The tanks are full of fry, taking their food six times a day, ready to go out into the streams, and it is with much rush of cans and men, etc., that they are started out on life's journey. Every outgoing baggage car must take its shipment or shipments of trout. Not only the baggage

cars do this, but also our commodious State Fish Car "Badger," which carries 200 of our ten-gallon shipping cans at a trip. Each can contains the proper amount of fry according to distance it is to travel, and has a chunk of ice on the cover to drip and keep the water at the right temperature in the can below.

The fish messengers are sent out with their alloted cans of fry, holding them over perhaps at some junction, or, through some delay, held up maybe a day at the railway station until the fish are delivered to the applicants; or they may have orders to plant the fish in the headwaters of a stream as soon as they can be gotten there. Seldom indeed does a complaint come in that the fish were not planted in good condition.

Every can carried in a given shipment contains the same number of fry or fingerlings. We measure all our fry by dry measure at time of shipping, by means of small screen-bottom dippers or strainers, each holding a certain number of fry or fingerlings at different ages. I know of no method more accurate or more easily operated than the above for measuring the fish put into each can.

As the hatchery tanks of fry are thinned out through shipping they are filled again from the hatching troughs with those that are coming on daily to the shipping age and size. They do not hatch all at once nor reach the shipping condition at the same time.

The several hundred thousand fry to be kept for fall shipment are now removed to the outside rearing ponds, where they will have more room, and the feeding, from six times a day, is cut gradually to twice a day.

The feeder is very careful that the fry all get some of the food, scattering the little particles of meat or strained "plucks" over the whole surface. He knows many anxious moments and days until all are feeding well and they start to grow rapidly. If he can see no dead ones on the clean gravel bottom, and they work to the head of the pond and fight the current, even the fish hatchery man feels some little joy in life.

The rearing ponds above referred to are small in size, many of them being almost square, while others are oblong, etc. We find, however, that the most satisfactory ponds are those about 8 feet wide, and from 30 to 50 feet in length, with a depth of 18 inches to 2 feet of water.

If one can arrange, as we are able to at Bayfield, to have the water fall a foot or more into each pond, it will help to aerate the water and also it creates a natural condition much appreciated by the fish. These long and rather shallow ponds give the desired current. They are also more easily covered with shades made of two by fours, in the form of gable-roof frames over which building paper or tar paper is stretched. We formerly did not use these, as we have considerable natural shade from trees, but we were greatly bothered with algae in the water. The shades do away entirely with all this trouble, giving the fish all the available room in the ponds and making it more agreeable when the time comes for removing them for sorting or shipping. Formerly this green "moss" would be seined in with the fish, getting into their gills, and causing no small loss.

Nothing can be more ideal for a bottom to these ponds than a layer of clean gravel, which can be raked over and over when cleaning, allowing the water to work through it and making for more sanitary conditions.

We have, now nearing completion, six fingerling or fry ponds, each 8 feet wide, 50 feet long and 40 inches deep, and the water will fall about eighteen inches into each pond. These are being built beside our Birch Run Springs stream, among the densest of natural shade. It is an ideal situation. We have tested the water for several years past, because we trout men know only too well that fine looking water, clear and beautiful, does not always assure success. This Birch Run water is the softest in use at any of our trout hatcheries.

We aim to raise at Bayfield each year quite a number of brook trout fingerlings, shipping many of them along in October, but saving a certain number each year to replenish our stock fish ponds and also those of our other trout hatcheries where the conditions are less favorable for raising fingerlings. We have nine hatcheries in our state, three of them being devoted to brook, rainbow, and brown trout. The Bayfield plant is more successful at this line than the others, in a number of ways, because the water is much softer than that at the other hatcheries.

Our Wild Rose Hatchery has the most beautiful water in abundance, natural shade, plenty of fall, sandy, clean locality, where the trout streams are the best in the state for fishing,

where there could hardly be a doubt left as to its suitability for the propagation of trout, yet here we have met with conditions unfavorable to an extent undreamed of. But if we can get the trout past the stage of absorbing the yolk sac, our trouble is past. The eggs that are taken there annually—some two to three millions—are shipped to the Bayfield hatchery, where they hatch into the strongest of fry and we have no losses in the fry stage.

The man with the feed pail and dipper, the man who selects the livers and plucks, the man that knows how to spread the feed and do a thousand other things properly, is truly the man responsible for the results, as it is with a successful stock raiser. For months and years he stands guard over these things and he may know little else and care less. It is confining work, but still very fascinating.

The fry are fed five or six times a day, at first, in the hatchery vats, with very finely ground food composed of one-half liver and one-half sheep plucks. We find the plucks an excellent food, because the fine particles float, giving the little fellows plenty of time to get it, whereas, the liver will settle quickly to the bottom. However, the fry that have learned how to feed take it before it reaches the bottom. This finely ground food must all pass through a sieve before being mixed with the water for feeding, to make sure that there will be no pieces large enough to harm the fry. It is fed a little at a time and often at first, and how they do eat! During the five or six weeks they have been in the hatchery fry troughs, they have been absorbing nourishment from the natural food sac. They are eager now for a change of diet, and the little particles of liver and plucks are taken eagerly. What fun it is to see them retain their places at the headwaters, where the current is swift, and work for the food. All these things work into a trout man's system, and become a part of him.

Some of these little fingerlings are now growing faster than others and some of them are destined to be, at maturity, much larger than others of the same age. These larger ones must be separated from the others, or else there will be a tremendous loss during the late summer, for the large devour the small, especially in the brook trout. Those who maintain that the rainbows are eternally eating up all the brook trout are, I believe, mistaken to a great extent. We all know the rainbow is a very

much hardier fish in suitable waters. We know it stands more abuse and is not subject to the copepod parasite that yearly carries off quite a number of our brook trout of two years of age and over in the wildest of streams, as well as in hatchery ponds. We do not remove the rainbow fry to sort, because we have not had any great loss through cannibalism, though there is just as much irregularity in size as among the brook trout at a given age. There is, however, one feature against the rainbow, in comparison with the brook trout, in that we find on the average a larger number of infertile eggs.

A few hundred thousand of these little beauties in a small space make a sight to behold, rolling to the surface to feed and sparkling in the sunlight with their small red fins and tails. The water fairly crackles as those little bodies hit the surface in masses.

The large breeders in the ponds will follow the feeder and his pail around the ponds and even come to the landing place and take food from his hand. One may see thousands of these trout at sunset jumping for flies, sometimes leaving the water three to five feet. To witness all this is living.

Allow me to add in conclusion that we have at Bayfield one of the finest equipped hatcheries in this country, in ponds, in buildings, in water and in grounds that compare with the best kept parks in the cities, and we are proud of our work.

PRIZES OFFERED FOR CONTRIBUTIONS.

For the purpose of stimulating interest in fisheries problems and the work of the American Fisheries Society the officers of the Society have decided to offer prizes for the best contributions. Three phases of fisheries work are included, the cultural, commercial and the biological, under the terms outlined in the statement by President O'Malley which follows.—EDITOR.

WASHINGTON, D. C., May 23, 1918.

To the Members of the American Fisheries Society:

In order to develop interest in fish culture and related subjects, and to stimulate expression regarding them, the American Fisheries Society has through its President and Executive Committee, decided to offer three prizes of $100 each, to be awarded at its meeting in New York City on September 9, 10 and 11, 1918, as follows:

1. For the best contribution on fish culture; either new or improved practical fish cultural appliances, or a description of methods employed in the advancement of fish cultural work.

2. For the best contribution on biological investigations applied to fish cultural problems.

3. For the best contribution dealing with the problems of the commercial fisheries.

A committee of three members of the Society, one a practical fish culturist, one a scientist and one a practical commercial fisherman, to be appointed by the President, will pass upon the material submitted. The conditions governing the competition are as follows:

1. Any person who is a member of the Society, or who duly qualifies as a member prior to September 1, 1918, may compete for the awards.

2. Each competitor is to notify Mr. John W. Titcomb, Recording Secretary, Albany, N. Y., before September 1 of the particular prize for which he intends to compete.

3. Each paper or exhibit offered in competition to be in the custody of the Secretary of the Society on or before September 3, 1918.

4. Each device, apparatus, process, or method offered for an award is to be represented by a sample, model or illustrated description, each to be accompanied by a complete statement of the points for which an award is asked.

The Society is to reserve the right to publish any papers or photographs submitted in competition prior to their publication elsewhere; provided, however, that in the event of failure to publish within nine months after the meeting the author will be at liberty to publish when and where he may elect.

5. The Committee appointed by the President is to determine the competitors who are entitled to awards, and the decision of the committee is to be final.

6. In order to obtain additional information, if desired, the committee may call before it persons who may have entered the competition, and also other persons.

7. If in the judgment of the committee no paper submitted on a given subject comes up to the standard decided upon by it the author shall not be entitled to any award.

8. The committee is to make its final report to the Society not later than the morning session of the third day of the meeting.

It is hoped that every fish culturist, biologist and persons dealing with the problems connected with the commercial fisheries will make a special effort to present a paper on the subject in which he is interested, as anything that will increase the efficiency of fish cultural operations or the output of the commercial fisheries is highly important at this particular time.

Very respectfully,

HENRY O'MALLEY, *President.*

THE 1918 MEETING.

Don't Forget the Annual Meeting to be held in New York City, September 9th, 10th and 11th.

Can you not secure for the Society one or more new members? Every man engaged or interested in fish culture should be a member of the Society. The fact that a man is unable to attend meetings is no excuse. The publications alone are worth more than the price of admission. If you cannot send applications, please suggest names to whom the secretary may write.

JOHN W. TITCOMB, *Secretary*,
Albany, N. Y.